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Technical Report

for

NASA - NAG - 8305

Optical Observations of HEAO-B Objects

by

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Summary

This project lasted from January 1980 to January 1982, (although through an informal arrangement with the HEAO scientists at the Center For Astrophysics in Cambridge, Mass., some observations were made in advance of the grant period and subsequently reduced under the grant). The project involved a collaboration with HEAO-B x-ray astronomers at the Center for Astrophysics in Cambridge, Mass, principally Dr. Fred Seward. We were provided with positions and error circles of optically unidentified x-ray sources near the galactic plane and we carried out searches within and around the error circles for optical counterparts for these sources.

49 x-ray source fields were searched in the course of 42 nights of observing and in all 62 individual stellar objects were studied.

No optical identifications of the x-ray sources were made. This negative result is surprising but not inconsistent with the experiences of other groups who took part in similar studies (Fred Seward, private communication, 1981).

Description of the Project

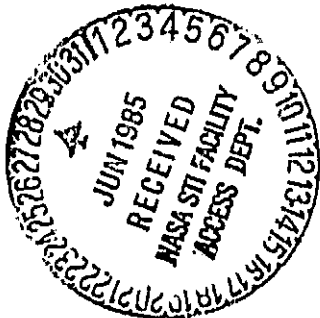
Equipment and Data Reduction. All observations were made with the 52-inch telescope at McGraw-Hill Observatory. The Mark II Reticon spectrometer (whose prototype is described in Shectman and Hiltner, 1976, Publications of the Astronomical Society of the Pacific, volume 88, p. 960.) with an intensified television guider was used to obtain digital spectra of objects in each HEAO-B field. The time-integrated spectra were displayed and studied at the telescope to see if any obvious emission line features found

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N85-28895

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in optical counterparts of galactic x-ray sources were present in the HEAO-B target fields (eg. Balmer lines, 4686A, 4640-50A, etc.) Since the spectra of known galactic sources can be time varying, in many cases the spectroscopic observations in this project included a series of spectra which could be studied later for time variability of features. White dwarf ("continuum") flux standards from the lists of Oke were also observed during the night to permit flux calibration of the spectra obtained in the x-ray fields. All spectra were recorded on magnetic tape and returned to Dartmouth where the REDUCE system (described in M. Kurtz, 1982, Ph. D. thesis, Dartmouth College) was used to flux-calibrate and noise-filter the spectra for a more refined search for unusual spectral features. Some of the objects were very faint and the individual spectra in a time series could be quite noisy. Kurtz devoted considerable time and effort to developing and implementing the necessary reduction techniques.

The searches at the telescope and the more refined searches at Dartmouth failed to reveal any unusual objects (there were, however, the inevitable "false alarms" which subsequent scrutiny failed to confirm). In fact, our experience with observing MK spectral standards with the same equipment in connection with an unrelated project on automated spectral classification indicated that the stars observed in the target areas were quite ordinary. Our disappointment was eased somewhat by Fred Seward at the Center for Astrophysics who reported that others doing the same sort of work had also had rather poor luck.

Staff. Besides the Principal Investigator, this work was carried out with the help of two Graduate Students (M. Kurtz and G. LaSala), a post-doctoral fellow (D. Fraquelli), and several undergraduates. We were also assisted by a part-time "data handler" who helped with the routine jobs of data reduction. Kurtz continued to work with the data after completing his Ph. D. in refining the noise-filtering procedure and in searching for peculiarities in the spectra.

Target Fields. Two trips were made to the Center for Astrophysics to obtain lists of optically unidentified x-ray sources and their error circles. Copies of CFA finding charts prepared from Palomar Sky Survey Prints were used to locate objects for the searches. Fred Seward also occasionally mailed us coordinates or finding charts for fields of interest.

Log of Observing Sessions. Observations for this project were carried out according to the following log. All dates are in Universal Time and the observing time in minutes reflects time spent in observing both the star and the sky nearby. The fields are named according to the charts supplied by the CFA except in three cases where Fred Seward supplied positions of un-named sources. These are designated "SEW."

DATE	OBJECT	TIME	DATE	OBJECT	TIME
8/16/80	1549+2023A	8	6/17/80	I1197G	14
	B	11		H	5
	1623+6148	11		I	14
	1704+241	40		J	25
	2225-2413	24		K	15
	SEW 7A	42	6/19/80	L	20
	B	5		I1199A	5
	C	10		B	5
8/17/80	1715+7046A	10		C	18
	B	15		D	18
	SEW 1A	5		E	18
	B	5		C	18
	2252-035	30	6/21/80	1912+1038A	5
8/20/80	SEW 5A	30		B	14
	B	30		C	14
	C	30		D	14
	F	60		E	7
				F	14
6/14/80	1635+1155	11		G	14
6/15/80	1548+1124A	5	6/22/80	1912+1031B	11
	B	15		C	20
	C	2		D	20
				E	11
	D	12		F	11
	1745+2744A	5	6/23/80	G	11
	B	30		H	11
	C	18		I	14
6/16/80	1525+0845A	5		A	11
	1635+1155A	5		J	14
	B	18		L	11
	C	18		J	16
	D	5	6/24/80	I1199H	9
	E	5		F	12
	F	5		J	18
	G	18			
	H	18	4/1/80	0837+1313	60
	I1197A	5	4/3/80	0809+4809A	28
	B	18		B	17
	C	1P		0835+5812	40
	D	31		1339+6030A	36
	E	5		B	20
	F	18	4/4/80	0837+1313	75
6/17/80	1340+6043A	7		0938+1151	20
	B	14		1247-0547	57
	C	14		1457+2225	60
	D	5	4/5/80	0849+2844A	20
	E	18		B	30
	1623+6145	5		C	30
	1636+1158A	10	4/6/80	0849+2828A	18
	B	5		B	12
	C	5		1339+6030A	26
	D	5	4/7/80	0830+1401	5
				0849+2828	5

DATE	OBJECT	TIME	DATE	OBJECT	TIME
4/7/80	0938+1151	42	9/11/79	0207+5420E	10
	1247-0547	35		F	10
4/9/80	0837+1313	3		G	10
	0951+7009	50	9/12/79	W44 A	5
4/10/80	0837+1313	36		B	15
	0835+5812	36	9/13/79	B	10
	1457+2225A	42			
	B	40			
4/11/80	0835+5812	36			
11/30/79	1052+606	24			
12/01/79	1052+606	60			
12/02/79	1052+606	40			
12/05/79	0115+63	50			
8/25/79	1854+0116 (W44) A	5			
	W44 B	5			
	C	5			
	D	5			
	B	5			
8/26/79	A	5			
	B	5			
8/27/79	B	60			
8/28/79	B	180			
8/29/79	B	300			
8/30/79	A	5			
	B	200			
8/31/79	B	30			
	A	5			
9/01/79	A	12			
	B	40			
9/04/79	A	10			
	B	70			
9/05/79	0206+5213A	220			
9/06/79	W44 B	20			
	0206+5213A	170			
	B	5			
	C	5			
	D	5			
	E	5			
	F	5			
	G	5			
	A	30			
9/07/79	A	200			
9/09/79	W44 A	10			
	B	20			
	0206+5213A	5			
9/10/79	W44 A	10			
	B	35			
9/11/79	0207+5420A	10			
	B	10			
	C	10			
	D	10			